LETTERS TO THE EDITOR

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A Bee's Movements in a Room.

THE following was communicated to me by a friend of mine, Mr. E. W. Winstanley, of Trinity College, Cambridge, and, as it may have some value respecting the relations of insects to flowers, I think it worth putting on record. The observations were written down on the day after the occurrence, when he related to me the facts, and I reproduce them here in his own words:—

"Sitting reading in my room (15 Jesus Lane) by the open window, about noon, October 21—a sunny day—I became conscious of a buzzing sound, and, on looking up, found it due to the entrance of a bee. Noticing that certain objects seemed to arrest the insect's attention, I paid special heed to its movements. It first went across to the pictures on the opposite wall, following them round the room, and hovering a short time close to each of the coloured ones, then passing out of the door, which was wide open; returning, after a few seconds, it flew straight to the gas-shades, which, two in number, are situated one on each side of the mantelpiece; it lingered over the top of one, and then passed on to the other, and repeated this movement. It now took a second tour of the pictures, and after stopping a moment or two near one of the brass knobs of the curtain-pole, came again to the gas-shades and made a closer investigation of them, both by hovering over the top and by entering at the bottom around the gas-burners. It then visited in succession four ornaments on the mantel-mirror, drew near once more to the large central coloured picture, made a second exit by the door, coming back almost immediately, and, after dwelling near the two small coloured pictures for the third time, flew straight out of the window.

"It never actually alighted anywhere, remaining near the objects by the rapid quiver of its wings. The whole visit the bee paid me occupied probably five minutes or less. Although I did not examine it closely, I considered it to be a hive and not a humble bee."

The special features to notice in the above are the systematic way the bee flew about, and the nature of the objects which attracted its attention.

Any one on surveying the room would admit, I think, that the gas-shades and the pictures are the most brightly coloured things in it.

The gas-shades are semi-opaque, lily-shaped, and tinted from yellow to bright pink upwards; in fact, they resemble very large gamopetalous flowers (corollas).

The pictures in the room numbered seven, consisting of a large frame enclosing five photochrome views, of two small photochromes, and four photogravures. My friend says it was distinctly the coloured ones that attracted the bee, giving the other ones a mere glance, as it were. The photochromes are vividly coloured, blue predominating.

The remaining objects visited, the ornaments, are not striking or large, but have flowers painted on them on a white ground, mostly resembling blue forget-me-nots. My friend was somewhat astonished at the bee regarding these, as he was not aware, till he looked, that the vases were decorated thus. He is not a botanical student, and has no bias towards any theory of the flower; it was the methodical way the bee went about the room that arrested his attention. It is mainly owing to this fact that I thought it worth while to make his observations known. Recently some observers have put forward reasons for considering that the colour of the flower exerts little attraction towards insects, and that it is chiefly the odour. The above piece of information favours decidedly colour attraction. There was no perception of odour, or any flowers or plants present in the room at the time.

To my mind it seems rational to assume that colour and odour may play somewhat equal attractions, the scent serving to bring bees from a distance, and the colour helping to guide them directly to the honey. A bee becoming accustomed to associate nectar with conspicuously coloured objects, might thus learn to visit flowers wholly from colour-sensation, and, not having sufficient discriminating power, visit other brightly-coloured things as well. J. PARKIN.

Trinity College, Cambridge, October 23.

A Test for Divisibility.

MAY I venture to supply a long-felt want amongst arithmeticians, viz. a general test of divisibility?

Let N be any integral number, and δ any divisor, then

$$\begin{aligned} N &= a + 10b + 10^2c + \&c. \\ &= a + b(\delta q + r) + c(\delta q + r)^2 + \&c. \\ &= \delta Q + a + br + cr^2 + \&c. \\ &= \delta Q + a + b(\delta q_1 + r_1) + c(\delta q_2 + r_2) + \&c. \\ &= \delta Q + \delta Q_1 + N_1 \\ &= \delta(Q + Q_1) + N_1. \end{aligned}$$

Here N_1 is the least general substitute for N, and is of the form

$$a + br_1 + cr_2 + dr_3 + \&c.$$

where the number of values of r_1, r_2 &c. cannot exceed $\delta - 1$. but may be much fewer, and constitute a recurring series found from

$$\frac{10^n}{\delta}, \text{ where } n = 1, 2, 3, 4 \text{ \&c.}$$

$$\begin{aligned} \text{Let } \delta &= 2, 5, \text{ then } N_1 &&= a \\ &= 4, &&= a + 2b \\ &= 8, &&= a + 2b + 4c \\ &= 16, &&= a + 10b + 4c + 8d \\ &= 3, 9, &&= a + b + c + \&c. \\ &= 7, &&= \left.\begin{array}{l} a + 3b + 2c + 6d + 4e + 5f \\ + g + 3h + 2i + 6j + 4k + \&c. \end{array}\right\} \\ &= 37, &&= \left.\begin{array}{l} a + 10b + 26c \\ + d + 10e + 26f + \&c. \end{array}\right\} \\ &= 11, &&= a + 10b + c \div 10d + \&c. \end{aligned}$$

and so on.

The practical importance of this general test must primarily depend on the brevity of the recurring period of r_n, but in special cases this objection may be removed.

Thus when $\delta = 11$, if $N_1 \div \delta = 11q$ we have

$$\begin{aligned} N_1 &= (a + c + \&c.) + 10(b + d + \&c.) \\ &= S \times 10S_1 = 11q. \end{aligned}$$

But $S - q = 10(q - S_1)$
where $(S - q) \div 10 = q - S = q_1$ suppose;
also $S_1 = (11q - S) \div 10$;

$$\therefore\ S - S_1 = 11\left(\frac{S - q}{10}\right) = 11q_1.$$

That is, the difference of the sums of the alternate series of digits is divisible by 11 if N or N_1 be so divisible. This result may be applied thus: Let a_3, b_3, c_3 &c. denote triple periods, and $\delta = 1001$, then

$$\begin{aligned} N_1 &= a_3 + 10^3b_3 + c_3 + 10^3d_3 + \&c. \\ &= (a_3 + c_3 + \&c.) + 10^3(b_3 + d_3 + \&c.) \\ &= S + 10^3S_1 \text{ which may be changed to} \\ &\quad S - S_1. \end{aligned}$$

Thus $S - S_1$ is a test for divisibility by 7, 11, 13, 77, 91, 143, 1001.

Again, if a_4, b_4, c_4 &c. denote quadruple periods and $\delta = 10{,}001$, then

$$N_1 = a_4 + 10^4b_4 + c_4 + \&c. = S - S_1$$

and is a test for $\delta = 73, 137, 10001$.

Again, if a_6, b_6, c_6 &c. denote sextuple periods and $\delta = 1{,}000{,}001$, then

$N_1 = a_6 + 10^6b_6 + c_6 + \&c. = S - S_1$ and is a test for $\delta = 101$; 9901.

As examples take

(1) $N = 807{,}929{,}122$; $\delta = 7, 11, 13, 143, 77, 91$;
$S - S_1 = 122 + 807 - 929 = 0$.
$\therefore$ the proposed number is divisible by δ.
(2) $N = 67, 3558, 3491$; $\delta = 73, 137$.
$S - S_1 = 3491 + 67 - 3558 = 0$.
(3) $N = 360, 4536, 7388$; $\delta = 73$.
$S - S_1 = 7748 - 4536 = 3212 = 73 \times 44$.
(4) $N = 390, 9569$; $\delta = 137$.
$S - S_1 = 9179 = 137 \times 67$.
(5) $N = 585622, 677027$; $\delta = 101$.
$S - S_1 = 91405 = 905 \times 101$.
(6) $N = 954221, 304387$; $\delta = 101$.
$S - S_1 = 649834 = 6434 \times 101$.

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When the periods consist of similar groups, as

222, 222;
123, 123;
333, 777, 444;
333555, 333555;
5174, 1399, 1399, 5174;

divisibility by the formula $S - S_1$ may be determined by inspection, and this conclusion will not be modified by like permutations of each group. Thus 123123, 312312, 132132 &c. are each divisible by 7, 11, 13, 91, 143 &c.

Lastly, since r_n changes with every value of δ, no general formula for the determination of primes can exist.

HENRY T. BURGESS.

Tarporley, West Norwood, October 16.

INTERNATIONAL CONGRESS ON TECHNICAL EDUCATION.[1]

IT is difficult to know how best to review a volume consisting of such varied matter as the Report of the Proceedings of an Educational Congress. Even when restricted to technical education, the subjects that may be legitimately discussed are very numerous; and with the constant widening of the definition, it is not easy to exclude any branch of knowledge, as outside the field of inquiry. After reading very carefully the closely-printed volume of nearly 300 pages, which includes the papers *in extenso*, and a summary of the discussions, we must own to some feeling of disappointment at the poverty of the results. Several of the writers and speakers are men of knowledge and experience, who write and speak with authority on their respective subjects; but, nevertheless, the volume before us adds little to what was previously known, and we look in vain through its pages for any new light to guide us in solving problems that are still imperfectly understood. The papers are, of course, of unequal merit, and we propose briefly to call attention to a few only, selecting rather those the authors of which show themselves abreast of the difficulties to be overcome.

The Congress was the fourth of its kind, the two previous meetings having been held in Bordeaux, in the years 1886 and 1895, and the first in Brussels in 1880. The latest Congress, held in London, was organised by the Society of Arts—a society which has always shown a deep and very active interest in technical education. It occupied four days from June 15, when M. Leo Saignat and the Duke of Devonshire delivered short introductory addresses, till Friday, June 18, when it was brought to a close by a few words of thanks from the chairman, Sir Owen Tudor Burne, to those who had assisted.

It is not easy to correctly group the contributions under separate headings. Several papers were descriptive of the methods and conditions of education in the countries and districts with which the authors were familiar. Some few treated of educational problems, and these were perhaps of widest interest. The vexed question of the organisation of instruction and of examinations was very fully discussed; a whole morning was devoted to papers bearing upon the teaching of domestic science; and a special feature of the Congress was the prominence given to the subject of commercial education.

Among the papers dealing with educational method, those on the teaching of chemistry were certainly the most informing. The character of the chemical teaching best adapted to the requirements of persons actually engaged in industrial pursuits, and also to school children preparing for such pursuits, had recently been the subject of a thoughtful report, prepared by a Committee specially appointed by the Technical Education Board of the London County Council. This report had been widely circulated, and both Dr. Witt, of Berlin, and Dr. Lunge, of Zürich, referred to it in their communications to the Congress. It is doubtful, however, whether either of these professors fully appreciated the problem, as it presents itself to organisers of evening classes in this country. Neither in Germany nor in Switzerland is there anything approaching to the teaching of technological chemistry, by means of evening lectures, to artisans. When Dr. Witt states, in his paper on the "Relation existing between the teaching of pure chemistry and applied chemistry," that he "cannot admit any fundamental difference in the methods of research," every one will agree with him; but when he says, "we want no schools for producing specialists," it may be reasonably thought that his generalisation is too far-reaching. There are successful dyeing schools in all parts of Europe, and he, himself, admits that "Dyeing, calico-printing, and paper-making are . . . industries which may rightly claim the necessity of some special instruction in the methods of manipulation," even if no other industries have like claims. Although Dr. Lunge, who is essentially a technologist, puts in a plea for the study of applied chemistry, his views do not differ essentially from those of Dr. Witt. He is at one with other chemical teachers in recognising the importance of training in the methods of research for all students. He says very truly: "Nothing in these times of ours is likely to turn out a first-class chemist, worthy of being later on put in charge of a large factory, who has not tried his hand at original research." Dr. Lunge insists, however, on the advantages of specialised training, and refers to the demand of Dr. Böttinger, head of a chemical factory, having under him a staff of more than one hundred chemists, for the establishment of more professorships of technological chemistry. It is, nevertheless, clear that the difference between the training in pure and applied chemistry which Dr. Lunge has in mind, consists mainly in the addition to the curriculum of technological students of a course of instruction in engineering, in order that they may advance beyond the position, to use his own words, of "testing slaves," to understand something of the processes of manufacture on a commercial scale. Dr. Lunge shares with most German chemists the opinion, that the knowledge of chemistry and technology that can be imparted to adults in night classes is useless from the manufacturer's point of view. He says: "I do not even think that apart from isolated exceptions, such knowledge is of much good to the foreman, whose duty it is to carry out instructions, and to see that the men do their work as prescribed by the staff." And, more definitely, he tells us, that "in Germany, even in those factories where the work is carried on with the greatest chemical refinement, the foreman and ordinary workmen are neither required nor even desired to know anything of chemistry." Dr. Lunge, in this statement, is, of course, referring to large chemical works in which there is a complete system of division of labour and sectional work, and where every difficulty, as it occurs, is at once submitted to some member of the large staff of chemists employed. But it is now generally admitted that there are many small trades in which a knowledge of chemistry is useful to the ordinary workman, and that the training, even when it proceeds from the process to the principle, may be made educationally valuable in supplementing the still imperfect, and too brief discipline of the elementary school. Prof. Armstrong's characteristic paper, indirectly bearing upon this subject, entitled "Heuristic instruction in physical science," was intended to show that the aim of sound science teaching should be to put learners in the attitude of discoverers; and there is no doubt that if such teaching were more general, the necessity for specialised instruction would be lessened, and a great part of the technical teaching of evening students might be remodelled. Dr. Armstrong scarcely did justice, however,

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[1] Report of Proceedings of the Fourth Meeting, held in London, June 1897.

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